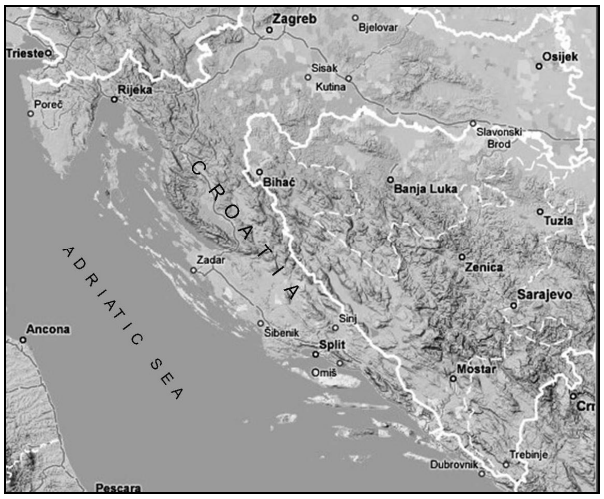
CROATIA – LAND OF LIMESTONES

Charles Hiscock



In 2008, my wife and I went to Croatia by flying into Zagreb, for a 12 day tour. The country around Zagreb was plain, generally fairly flat with unexceptional scenery. Zagreb, however, provided the first suggestions that the country was going to be much more interesting geologically than the guide books suggested (if they mentioned geology at all). To the north of the city is a range of mountains where the locals go for recreation and taking the hot springs. This last snippet of information was a sure sign that there was more to Croatia than the culture, art and scenery that the guide books covered. To be fair, the guide books are aimed at tourists who have interests in art, archaeology and culture – the Romans and Venetians in particular which Croatia has in abundance – and those with no interests at all except sun and sea. It does not help that the geology of the country is poorly recorded and generally unavailable. The geological map that I was able to obtain was in French, printed in Germany and only as recent as 1969. Still, it gave me a broad insight into the geological structure. The one guide book that we had briefly stated that the Croatian countryside was predominantly karst, the word being derived from the Slovenian for denuded scenery of the Karst region of the old Yugoslavia of which, of course, Croatia was a part before 'The War' of 1991 – 1996.

Zagreb (stock photo)

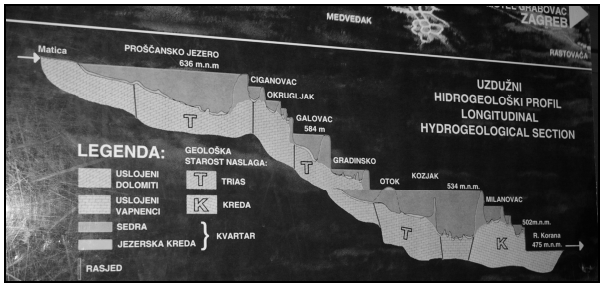
We spent two days in Zagreb taking in the art, architecture and culture of the city which was special and worth the time. Our tour then started, taking us towards the Adriatic coast which was when the geology began to hot up. We passed through the industrial city of Karlovac and along the way, saw many bombed and shelled abandoned houses and villages, unrepaired after The War. There were many memorials to those who died, notably men in their late teens to early thirties. To us, it was a sad and poignant reminder of the TV and radio reports of the battles, violence and fighting which, then, seemed so far away.

As we had found out, it was less than 2 hours flight from the UK. Indeed, our first comfort stop was at a roadside café where, not far away, was a roadside shrine to three young men who had died in The War. This sober stop very soon gave way to our first taste of the geology. At the next, it was spectacular and wonderful. The road ran high along the east side of the River Korana, itself in a gorge up to 100 feet deep, with high waterfalls rushing over the opposite side of the gorge, each waterfall producing its own prograding tufa promontory. The river gushed from holes, gullies and through the buildings from an incredible maze of waterways around and through the village. Each waterway was formed by, and forming as it flowed, tufa channels and promontories. Where the crystal clear but slightly blue water fell into the gorge, mounds of tufa built up around the plunge pools. The river Korana had flowed from

Jurassic through Cretaceous limestone and 'flysch' for up to 80 km and had picked up high levels of carbonate in solution. (Flysch refers to sediments produced by the erosion of uprising and developing fold structures and are generally marine sandstones, breccias and conglomerates.) At this village, Slunj, the river flows from the Cretaceous onto a block of Triassic rocks uplifted by faulting. Where the river cuts the fault system, it turns abruptly 90 degrees, over-deepening the fault line and providing conditions for the series of waterfalls.

Village waterfalls at Slunj

The stop was brief but gave us a foretaste of the geology that was to be seen at our next stop, the Plitvice Lakes.



Geology of Plitvice Lakes

The river Korana rises, or, more correctly, emerges from a block of Upper and Middle Jurassic limestones and dolomites and within a few kilometres, flows onto an uplifted block of Upper Triassic dolomites and limestone across another fault line. From this point, the river is at 636 metres (2098 feet) above sea level and drops by a series of 10 tufa-dammed lakes for a total of 134 metres (442 feet) over a distance of about 2.5 km. The lakes vary widely in area and depth but all ten contain blue, clear water and support much freshwater life, including a species of fish unique to these lakes. The most fascinating feature of the lakes is the action of carbonate-fixing algae which grow in frond-like, cream coloured masses on all the submerged vegetation. Here is an environment similar to that which existed 600 million years ago when carbonate-fixing algae developed in vast amounts, releasing oxygen into the atmosphere, except that the water is fresh and the algae are not blue and green. These freshwater algae fix the carbonate on anything in the water, gradually building up masses of tufa where the water is exposed to the air e.g. waterfalls, spouts and channels. As a result, dams of tufa are always building and prograding downstream holding water back in a series of lakes. The Lakes Reserve is entered by a visitor centre where, in the foyer, we were surprised to see a cross-sectional diagram of the geology as it affected the lakes and it clearly showed that a series of faults have dropped the Triassic rocks down stepwise. Each drop has produced a waterfall or a series of falls which have then been dammed by tufa over a long period of time. Some of the dams are 30 feet high while others are mounds, supporting a wide variety of water and marginal plants, animals and insects. In a few places, we saw Roman snails which are probably the same species as those found in the Cotswolds particularly in the woods around Chedworth. They are said to have been introduced by the Romans who used them as food. The tourist walk is along a series of footpaths and boardwalks – rustic timbers supported on logs driven and themselves being incorporated into the tufa. Except in a few places there were no handrails and where the water shot through the slats of the boardwalk the wood was slippery so one was able to get soaked feet with the greatest of ease. (No Health and Safety here – just the place to use good old common sense!)

Highest waterfall and mist

After our visit to the lakes of Plitvice, our journey continued roughly south to the shores of the Adriatic Sea, to Starigrad Paklenica on one of the many inlets and bays that are a feature of the Croatian coast. From our room the view right was of the deep-blue, motionless sea bordered by conifer woods with a ruined castle and a small jetty. To the left we could see the almost bare limestone mountains rising up to 1757 metres (5800 feet). Immediately behind the village within 2km of the beach, a deep gorge cuts up into the mountain range with a small stream running towards the sea. The gorge is used for international rock climbing and abseiling competitions and was clearly a very popular place with the local enthusiasts. For the first 1-2 km from the beach the rocks are Oligocene flysch deposits after which the stream cuts through steeply rising Lower Cretaceous limestone into the centre of the range, which is Middle and Upper Jurassic limestones and dolomites. The stream builds up small amounts of tufa but it is quickly destroyed by floods descending the gorge.

View of the mountains near Starigrad

The next stage of our tour was to visit the Krka River. This beautiful, scenic river and its waterfalls are often shown in holiday brochures. It did not disappoint. The Krka rises about 50km inland amongst Triassic flysch and limestone and flows south west over upper Cretaceous flysch onto Oligocene flysch alternating with bands of Cretaceous sediments. Near the town of Stritovci the water falls steeply for 1 – 2 km over a series of spectacular waterfalls, each produced by a prograding tufa promontory. The water flows in fast streams across the top of each drop until it rushes over the waterfalls in a white, foaming cascade. Near the top, a visitor centre displays some traditional trades which have used the power of the water over many centuries. The blacksmith uses the water to drive the bellows, the flour miller uses it to drive the stones, wool is washed by the swirling flow and large wooden stamps pound the wool to remove the oils. From the visitor centre the main footpath weaves gradually downhill, criss-crossing the many little waterways, with larger branches of the river collecting up the little ones to rush over the falls.

Krka river-bottom falls

The noise of the water makes any conversation or birdsong difficult to hear. Gradually, the path levels out onto a grassy area bordering the tree-lined river bank which now encloses a serene, smooth river about 100 metres wide. A bridge crosses the river giving a superb panoramic view of the waterfalls as the river tumbles down the valley and over the tufa falls. Looking downstream, the river quietly flows through a gorge about 200 metres high. On one side at the end of the grassy patch, a boardwalk leads to a jetty from which a boat can be boarded. The voyage takes about 45 minutes gently down river. After some time, the river turns sharply to the left and passes through a continuation of the gorge cut through the limestone mountain ridge which has been on our left side since we left the falls and passes under a ruined road bridge, a victim of The War and still not repaired. The boat trip ends at the small town of Skradin. The watercourses and enclosing woods and bushes provide good cover for a wide variety of birds and animals. Water snakes were seen in the pools and large numbers of fish could be seen in the clear water while nightingales, blackcaps, Cetti's warblers and other

spring songbirds could be heard proclaiming their territories. All in all, a wonderful experience! After passing Skradin, the Korana becomes wider and slower and, after a few kilometres, flows past the town of Sibenik. The river gives the impression of the sea but this attractive town lies on the north side of the river as it flows to the sea through a narrow cleft in the limestone. The channel is only about 100 metres wide and is the only outlet for the river, which for a town on the Adriatic coast, was an asset in the unstable times past when invaders invariably came by sea. The resourceful townsfolk hung heavy chains across the channel just below the surface to deter any ships from sailing through to attack Sibenik.

The remainder of our tour took us down the Dalmatian coast of Croatia. Like the stay at Paklenica, the hotels are beside the sea with the mountains of limestone and dolomite rising abruptly behind the narrow coastal shelf on which all the towns and villages are built. The most spectacular of these mountain ridges, the Biokovo range, runs behind the towns of Omis and Makarska as far as the port of Ploce. Between Omis and Makarska the road hugs the mountain on a ledge cut out at around 300 metres (1000 feet) above the sea. Wonderful views of the mountains were obtained with many demonstrating the thrusting, faults and folding caused by the subduction of the European plate beneath the African plate. It has pushed up accretionary prisms of Mesozoic limestone and dolomites en-echelon, which can be seen by looking at the map of the Dalmatian coast. The myriad of islands which lie lengthwise off the coast are narrow and up to 60 km long, while the ranges inland from the coastal ridge lie compressed into folds like corrugated cardboard. On the coast, Eocene and Palaeocene flysch are common. We sat on the headland overlooking Makarska enjoying the view when I realised that we were sitting on Cenozoic limestone formed from the foraminifera Nummulites almost identical to that we had seen in the Pyrenees in 2007. As one goes inland, the rocks become older, progressing through Cretaceous, Jurassic and Triassic limestones and dolomites. Away from the coast the en-echelon mountain ranges are lower and much more rounded due to erosion and

Dalmatian Coast north of Makarska

are well vegetated compared with the bare and sparsely covered rock along the coastal fringes. Subterranean rivers are common. Just north of Makarska, we could see fresh water welling up in the sea just off the cliffs. Obviously, a significant river was running into the sea through the near vertical cliffs. South of Dubrovnik, a large river flows straight out of the base of the cliff into the sea. A hydroelectric power station has been built to harness the power of the river and the electricity is then fed up and over the mountains and sold to Bosnia-Herzegovina. Here, Croatia is only 3 km wide so the river flows for almost all its length through Bosnia-Herzegovina yet the country has to buy back the electricity. To the north-west of Dubrovnik lies the dock area and, alongside, a large river flows into the sea through the towering cliffs and beneath a new bridge of which the Croatians are very proud. The river is the shortest in Croatia, being only 7 km long. What the Croatians do not tell you is that 40km of it runs through Bosnia-Herzegovina. Our guide told us that the 'spring' comes from the mountain

Mountains near Makarska showing thrusting and faulting.

at the head of the sea inlet but all we could see from the road was a large brick building under which the river flowed over a low weir. In fact, when we queried that such a large river was flowing into the sea, the answer made it clear that the 'spring' was the exit from a large cave system from which the river ran into Croatia. These subterranean river systems are huge and while we are familiar with them in Britain, ours are on a much smaller scale.

From the plain scenery around Zagreb and on the way to the coast, the geology blossomed like the flowers. The vivid yellow Spanish broom was everywhere up the mountain sides. The small rocky fields, separated by rough donkey tracks, sprawling up the mountain sides were ablaze with all sorts and colours of spring flowers. So, when we had had our fill of the geology around us, we could take in the beauty of the trees and flowers and listen to the nightingales trilling, seemingly from every other tree and bush. Like the flowers and the birds, the rocks provided surprises and delights at almost every corner of the journey. Go – you will not be disappointed. When you have seen enough, just relax and take in the scenery. Visit the historic sites – the Palace of Emperor Diocletian at Split, the medieval port and city of Dubrovnik, the Venetian town of Zadar, the islands of Brac and Hvar. Maybe you will have a few moments to enjoy the sun on a pebbly beach and perchance, share it with some Nummulites.

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All photos by Charles Hiscock unless indicated otherwise

GUIDE LAUNCH

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L to R: Elizabeth Devon, Fiona Newcombe, Isobel Geddes Photo: L D-H

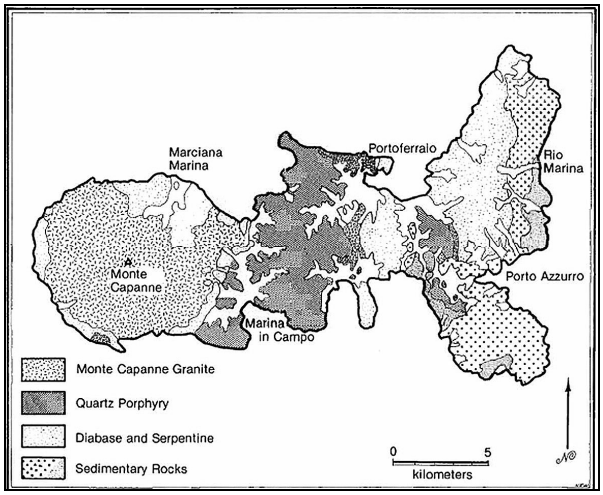
Sunday September 21st 2008 saw the official launch of the new WGG guide to the Vale of Pewsey at Milk Hill above Alton Barnes by Fiona Newcombe, Director for the North Wessex Downs AONB.

A VISIT TO ELBA
October 2008
David Burford

Elba lies off the Italian coast between the industrial town of Piombino on the mainland and the French island of Corsica. The local airport is at mainland Pisa from which you go by coach to Piombino. Ferries travel between Piombino and Ferrario on Elba.

My visit was on a walking holiday between the 8th and 15th October 2008. Visiting dates are important because this is at the end of the tourist season and the following week facilities start to close down.

An article from the web says that for Elba as a whole its geology is 'very interesting for the structural complexity' (bless it!). Even the zones making up the island are described as Complex 1, 2, 3, 4 and 5. These Complexes have been stuck together by a host of tectonic shenanigans (that are not further discussed here). Observable geological history begins in the Late Cretaceous and major changes occurred up to the Late Miocene /Pliocene epochs.



Elba may be thought of as having a north-south twin hammerhead at its east (mainland) end, a central short east-west shaft and a roughly circular west end to the shaft. All of this is within a total length of 27km. We were based on the west end at